Chapter 3

Methodology

This section entails consumers' reaction to the public water supply and the collection, storage and testing procedures for the 20 samples. The 20 samples were collected within 5 days based on a single visit to each site.

The survey was conducted on consumers staying in the 20 selected sites. The survey comprised of 80 completed sets of questionnaire collected from 4 consumers of different houses of a particular site. The survey results in Chapter 4, section 4.5 is an average of the 80 completed questionnaire. The questionnaire distributed is shown in Appendix 2.

The collection, storage and testing procedures for all the 20 samples were carried out as described below:-

3.1 Collection

Sampling points were selected such that the samples were representative of the water from the distribution system. The tap water was collected from the distribution system and not from the storage tank. In most cases it was from the garden tap or the kitchen sink.

Before each collection, the tap was wiped to remove any dirt by using a clean cloth. Then the tap was turned on at a maximum flow for 1 minute. The collection bottle was rinsed twice with the water being collected and the

tap water was collected in a 1500 ml polyethylene plastic bottle without adjusting the flow.

3.2 Storage

All samples were tested for pH, temperature, colour, residual chlorine, hardness, turbidity and sulfate as immediately after collection. Whenever the analysis could not be carried out immediately (e.g. for heavy metals), the samples were stored in the collection bottle and refrigerated in the dark at 4°C.

3.3 Testing methods

Whenever possible, the samples were tested according to APHA Standard Methods, 18th Edition 1992 for the Examination of Water and Wastewater. The testing method for each parameter is as specified below and it applies for all 20 samples. Prior to most testings except for the turbidity parameter, all the 20 samples used were filtered through a membrane filter with a pore size of about 0.45 μm.

3.3.1 Testing method for colour

The colour of the 20 samples were determined by visual comparison of the samples with known concentrations of coloured solutions.

The stock coloured solution of 500 units was prepared by dissolving 0.623 g of K_2PtCl_6 and 0.50 g of $CoCl_2.6H_2O$ in distilled water with 50 ml conc. HCl and diluting to 500 ml with distilled water. The stock solution was then diluted into known concentrations (standard solutions) of 5 units to 70 units.

The filtered samples and standard solutions were poured into nessler tubes to 50 ml mark. The samples were compared against the standards by looking vertically downward through the tubes toward a white surface.

(Reference : 2120 B Visual Comparison Method of APHA Standard Methods, 18th Edition. Page 2-2 to 2-3 under the section Physical and Aggregate Properties).

3.3.2 Testing method for pH and Temperature

The pH of the filtered samples were measured using the pH meter. Before measuring the pH of the samples, the pH meter had to be calibrated with the standard solution of pH 4, 7 and 9. However this was not required prior to every sample. A check was carried out to measure the pH of the standard after a few runs. If the pH meter did not show the accurate reading, then only was the pH meter recalibrated.

The temperature of the tap water samples collected were measured at the site using a digital thermometer with a single decimer point in °C.

3.3.3 Testing method for Turbidity

The turbidity of the tap water samples were measured using the turbidity meter. Having similar operating procedures to the pH meter, the turbidity meter was calibrated with standard solutions of 0, 5 and 10 NTU.

Prior to any measurement, the standards or samples were poured carefully into vials with marked volume to avoid the formation of bubbles for better accuracy. The vial was then placed into the turbidity meter for measurement. In this case, no dilution were required for all samples as all the readings were within the calibrated range.

3.3.4 Testing method for Hardness

The tap water sample was transferred into a conical flask using a 50.0 ml volumetric pipette. Subsequently 1 - 2 ml of the pH 10 buffer solution and 5 - 10 mg of Eriochrome Black T Indicator were added and mixed. The same procedure were carried out for the blank and the standard calcium solution. The standard calcium solution was needed to obtain the value for B as described below.

Both the blank and the sample were titrated with 0.010 M EDTA from a reddish solution to an end point of bright blue. The tap water hardness was calculated based on the formula below:-

$$\text{Hardness} = (A \times B \times 100) / \text{ml sample} = \text{mg/l as } CaCO_3$$

where A = ml titration for sample - ml titration for blank

B = mg $CaCO_3$ equivalent to 1.00 ml EDTA titrant

(Ref : 2340 C EDTA Titrimetric Method of APHA Standard Methods, 18th Edition. Page 2-36 to 2-38 under the section Physical and Aggregate Properties).

3.3.5 Testing method for Residual Chlorine

For all the 20 samples, 150 ml sample volume was chosen based on the requirement that the titrant used, 0.01N $Na_2S_2O_3$, should be within 0.2 ml to 20 ml for the starch-iodide end point.

150 ml of sample was transferred into conical flask where 5 ml CH_3COOH and 1 g KI were added and mixed thoroughly with a rod. The solution was then titrated with 0.01 N $Na_2S_2O_3$ until the solution turned to pale yellow. At this point, about 1 ml of starch solution was added and the titration was continued until a deep blue end point was obtained. The same procedure was carried out for the blank.

The residue chlorine content was calculated based on the following:-

Residue chlorine = (A x B X 35.5 x 1000 ml / l) / C

Where A = ml titration for sample - ml titration for blank

B = N (normality) of titrant, in this case, 0.0101N

C = volume of sample in ml

(Ref : 4500-Cl B Iodometric Method I of APHA Standard Methods, 18th Edition, Pages 4-38 and 4-39 under the section 'Inorganic Nonmetallic Constituents').

3.3.6 Testing method for Sulfate

100 ml sample was measured into the conical flask and 5.00 ml conditioning reagent was added and stirred. While stirring, a spoonful of $BaCl_2$ crystals were added and the clock was started. The stirring was kept at constant speed for 1.0 min.

Immediately the solution was poured into a UV cell and the turbidity of the solution was measured for 4 minutes at an interval of 30 secs using the spectrophotometer at 420 nm.

The same procedure were used for the standards. A calibration curve was drawn based on the readings for the standards. The results of the samples in mg / l SO_4 were obtained from the calibration curve. The calibration curve is a graph of sulfate concentration in mg / l SO_4 versus readings from spectrophotometer.

(Ref : 4500-SO_4^{2-} E Turbidimetric Method of APHA Standard Methods, 18th Edition, pp. 4-134 and 4-135 under the section 'Inorganic Nonmetallic Constituents').

3.3.7 Testing method for metals

The determination of metals such as Barium, Cadmium, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Nickel and Zinc were carried out using the Inductively Coupled Plasma (ICP) method.

Prior to the testing, all the 20 samples were filtered using a 0.45μm filter paper. The standards were prepared according to the APHA Standard Methods, 3120 B. Inductively Coupled Plasma (ICP) Method Part 3, pages 3-34 and 3-39.

The standards consists of :-

1) blank which is distilled water,

2) Chromium, Manganese, Nickel, Copper, Zinc, Cadmium and Lead at 20 μg/l, Iron at 40 μg/l, Magnesium and Barium at 20 mg/l.

3) Chromium, Manganese, Nickel, Copper, Zinc, Cadmium and Lead at 40 μg/l, Iron at 80 μg/l, Magnesium and Barium at 40 mg/l.

Prior to the sample run, the ICP was calibrated with the standards. After every 10 sample run, a blank run was carried out to check whether the ICP results were still accurate. If the readings showed 0 for the blank run, then the sample run is carried on. If not, the ICP has to be recalibrated with the standards before the next sample run .